

MEMO

To: Pine Grove Solar, LLC

From: Jenn D'Augustine, PWS (Tetra Tech)

Date: December 20, 2021

Subject: Pine Grove Solar Biological Resources Technical Memo

INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) was retained by Pine Grove Solar, LLC to conduct a desktop evaluation and onsite survey for biological resources such as state and federal listed threatened and endangered (T&E) species and potential sink hole areas in support of the proposed Pine Grove Solar Project (Project) in Madison County, Kentucky. The Project is a utility-scale solar energy facility to be developed on a collection of privately-owned properties totaling approximately 471.8 acres (Project Area; see Figure 1) and will consist of solar photovoltaic panels and associated racking, inverters, and a substation transformer, which will connect to a transmission line.

Tetra Tech, on behalf of Pine Grove Solar, LLC, prepared this Biological Resources Technical Memorandum to summarize the findings of publicly available desktop resources and the results of a field habitat survey of the Project Area for the potential presence of federal and state listed T&E species as well as identified potential constraints associated with sinkholes. This memo includes a description of the Project Area, regulatory background, survey methodology and results, and recommendations and conclusions for the Project.

PROJECT AREA DESCRIPTION

The Project is to be developed on a collection of seven privately-owned tax parcels totaling approximately 471.8 acres in Madison County, Kentucky (Figure 1). The Project Area is located approximately 1.5 miles southeast of the unincorporated community of Bybee, Kentucky.

The Project Area is located within the Major Land Resource Area (MLRA) known as the Lexington Plain Section of the Interior Low Plateaus Province of the Interior Plains. This MLRA consists mostly of gently rolling terrain with some isolated hills and ridges. Local relief is about 160 to 333 feet (50 to 100 meters) above mean sea level (amsl) on the highly dissected hills and 80 feet (25 meters) amsl on the undulating, broad upland plains (Natural Resource Conservation Service [NRCS] 2006).

The Project Area is relatively hilly descending sharply toward an unnamed tributary to Drowning Creek in the northeast, and Butler Branch in the southwest. Most of the Project Area is approximately 910 feet amsl, although elevations vary, at approximately 660 feet amsl near the unnamed tributary to Drowning Creek in the northeast, and 680 feet amsl near Butler Branch in the southwest.

Land use in the Project Area is rural agricultural/livestock land in private ownership. It is comprised almost entirely of grassed pastures, hay ground, and cultivated farm fields. Roadside edges and pastures consist of mowed native and non-native grasses and forbs. Linear rows of trees extend into several of the agricultural fields. Numerous ponds and stream are present within the Project Area (Figure 2).

REGULATORY FRAMEWORK

Federal Law

The United States Fish and Wildlife Service (USFWS) administers the Endangered Species Act (ESA) and maintains a list of federally listed T&E species. The ESA mandates protection of federally listed T&E species and their associated habitats due to low populations, sensitivity to habitat alteration, and/or cultural significance. The ESA does not protect plants on private land unless there is a federal nexus. Therefore, activities that impact listed plants on private lands but do not have federal involvement are not impacted by the ESA. Significant changes to the habitats of T&E species and projects that have the potential to result in a “take” require scrutiny by USFWS and may require special permitting or mitigation measures to avoid or reduce impacts to T&E species. The ESA also makes it unlawful to “take” any T&E species. Take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in any such conduct.” Significant modification or degradation of T&E species’ habitats are considered “harm” under ESA regulations. Activities that knowingly or unknowingly result in take or harm are subject to financial and criminal penalties under the ESA. Conducting due diligence assessments, siting facilities away from protected resources, and considering the need for special permitting or mitigation measures to avoid or reduce impacts to T&E species serves to reduce the risk of these impacts.

Bald and golden eagles are protected by the Bald and Golden Eagle Protection Act (BGEPA; as amended, 1962). The BGEPA prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles, including their parts, nests, or eggs. The BGEPA provides criminal penalties for persons who “take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle (or any golden eagle), alive or dead, or any part, nest, or egg thereof.” The BGEPA defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.” For purposes of these guidelines, “disturb” means: “to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available: injury to an eagle, a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior, or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior.” In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle’s return, such alterations agitate or bother an eagle to a degree that interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death, or nest abandonment (72 Federal Register 31156).

Numerous other migratory avian species are protected by the Migratory Bird Treaty Act (MBTA; 50 Code of Federal Regulations 10.13). The MBTA prohibits the taking, killing, possession, transportation and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. Unlike the ESA, the MBTA does not permit the “incidental take” of migratory birds. On October 4, 2021, USFWS published a final rule overturning a January 7, 2021 rule on the interpretation of incidental take and clarifying that incidental take is prohibited under the MBTA with the application of USFWS’ enforcement discretion and consistent with judicial precedent. The rule indicates that the anticipated impact on solar generation facilities will be implementation of best management practices that avoid or minimize incidental take of migratory birds, similar to those imposed on wind generation facilities, such as pre-and post-construction bird surveys, monitoring bird use and mortality, and limited use of deterrent systems such as streamers and reflectors.

State Law

Kentucky T&E species laws are generally limited in scope and defer to federal regulations. Chapter 150 of the Kentucky Revised Statutes (KRS) establishes the Kentucky Department of Fish and Wildlife Resources (KDFWR) as the state agency responsible for conservation of the state’s wildlife resources. The Kentucky Endangered Species Protection Act (KRS §150.180, 183, 260, 280, 990) sets forth statutes for the protection of T&E species within the state. Federally listed T&E species that occur in Kentucky are automatically listed by the state, and state-listed species are identified in Kentucky’s Comprehensive Wildlife Conservation Strategy (published by KDFWR in 2013). KDFWR enforces wildlife diversity regulations that ban the import, transport, and possession for resale or sale of any endangered species of wildlife (KRS 150.183).

The Office of Kentucky Nature Preserves (OKNP) implements the Kentucky Rare Plant Recognition Act and identifies and designates state T&E plant species. Plants recognized as T&E species by OKNP are the property of the landowner, and Kentucky law shall not use T&E plant species to impede the development or use of public or private lands (KRS 146.600). Additionally, OKNP maintains the Kentucky Natural Heritage Database that contains information on the distribution, abundance, and life history of flora, fauna, and natural communities in Kentucky. This database is available publicly through the Kentucky Biological Assessment Tool (KBAT).

METHODS

Desktop Review

Tetra Tech performed a desktop review for the Project using publicly available information to evaluate potential biological and land use resource constraints on and around the Project Area. This review included web service inquiries for T&E species, soils, wetland, regulatory review, and geological database searches.

U.S. Geological Survey (USGS) National Gap Analysis Program (GAP) spatial data was evaluated to determine the Project Area's potential to support T&E species or designated critical habitat (USGS 2018).

The following data was requested and reviewed for the Project to determine the potential for T&E species occurrence in or near the Project Area:

- Review of the Kentucky Natural Heritage Database was requested through KBAT in November 2021 (Project ID: 22-0068) (OKNP 2021). OKNP provided a list of T&E, special concern plants and animals, or exemplary natural communities that they monitor within the general Project Area (Attachment A).
- USFWS data for the Project Area was requested through the Information for Planning and Consultation (IPaC) project planning tool. USFWS provided an informal federal T&E species list on November 2, 2021 that identifies T&E species and critical habitat that may occur within the Project Area (USFWS 2021) (Attachment B).
- Sinkhole data for the Project Area was downloaded from the Kentucky Geological Survey (KGS) (KGS 2014). The data provided the locations of historical sinkholes within the Project Area. A preliminary evaluation of habitat present within the Project Area was conducted considering each federal and state T&E species' preferred habitat.

Field Survey

Tetra Tech biologists conducted a site reconnaissance on November 8 through 9, 2021, which included completion of a qualitative assessment of potential habitat present within the Project Area. The purpose of the survey efforts was to investigate the Project Area and determine its suitability to support federal and state T&E species. Tetra Tech biologists recorded all habitat types present, as well as habitats that could specifically support the T&E species listed in the USFWS IPaC or OKNP KBAT data provided for this Project.

In addition to habitat surveys for T&E species, Tetra Tech performed a site-specific investigation for historical and potential sinkholes, including reviewing for sinkhole openings and/or exposed rock areas. If an opening was observed the following data would be collected:

- Document the number of openings, the size of the opening, and if the openings are greater than 6 inches in diameter;
- Diameter of the shaft or shafts that are greater than 1 foot;
- Depth of the shaft or shafts that continue less than 50 feet and that terminate with no visible fissures that bats can access;
- Determine if openings are prone to flooding, collapsed shut and completely sealed, or are otherwise inaccessible to bats; and
- Openings that have occurred recently (i.e., within the past 12 months) due to human activity or subsidence.

RESULTS

Desktop Review

The results of the above-referenced database searches and field visit are summarized in Table 1 and additional information for each species is included after the table. The OKNP KBAT indicated one state-listed species of special concern has the potential to occur within the Project Area including the loggerhead shrike. This species is not subject to review under the Section 7 ESA. The OKNP KBAT list is included in Attachment A. The USFWS IPaC indicated that 12 federally listed species have the potential to occur within the Project Area. These include four mammals, six clams, one flowering plant, and one insect. No USFWS designated critical habitat occurs within the Project Area. The USFWS IPaC list is included in Attachment B.

Sinkhole data from KGS for the Project Area was reviewed and no historical sinkholes were identified.

Field Survey

A desktop review of potential habitat for the Project Area was performed using GAP data prior to initiation of the field survey. Analysis of GAP data indicated that the Project Area's cover type consists of Agricultural and Developed Vegetation. The Project Area land is primarily rural agricultural/livestock land. It is comprised almost entirely of cultivated farm fields, grassed pastures, and hay fields. As such, the only moderate-quality natural habitat remains along the unnamed tributary to Drowning Creek in the northeast and Butler Branch in the southwest, and several small, forested areas located across the Project Area. The forested areas observed within the Project Area were characterized as mixed hardwood forest dominated by deciduous species including, but not limited to, American sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), black willow (*Salix nigra*), boxelder (*Acer negundo*), eastern cottonwood (*Populus deltoides*), eastern red cedar (*Juniperus virginiana*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), shagbark hickory (*Carya ovata*), shellbark hickory (*Carya laciniosa*), and swamp white oak (*Quercus bicolor*).

Streams identified within the Project Area were assessed for a variety of characteristics including, but not limited to, stream morphology types (pool, riffle, run), turbidity, and substrate components, which was used for the basis of determining the presence of suitable habitat for listed aquatic species. Data forms documenting stream characteristics within the Project Area are presented in Attachment C. Streams identified, delineated, and investigated during the field habitat evaluation are shown on Figure 2.

A site-specific investigation for historical and potential sinkholes, including reviewing for sinkhole openings and/or exposed rock areas, was conducted. A total of seven sinkholes were observed within the Project Area. These sinkholes were characterized as sinkhole ponds, with no evidence of exposed rock or openings which would provide suitable habitat for bat species. Photographs of each sinkhole are included in Attachment D. Figure 3 includes the locations of the sinkholes identified within the Project Area.

Table 1. Species with Potential to Occur within the Project Area

Common Name	Scientific Name	Status ¹	Potential Habitat Present	Effect Finding
Mammals				
Gray Bat	<i>Myotis grisescens</i>	FE	No	No effect
Indiana Bat	<i>Myotis sodalis</i>	FE	Yes	May affect, not likely to adversely affect
Northern Long-Eared Bat	<i>Myotis septentrionalis</i>	FT	Yes	May affect, not likely to adversely affect
Virginia Big-eared Bat	<i>Plecotus townsendii virginianus</i>	FE	No	No effect
Bivalves				
Clubshell	<i>Pleurobema clava</i>	FE	No	No effect
Fanshell	<i>Cyprogenia stegria</i>	FE	No	No effect
Purple Cat's Paw	<i>Epioblasma obliquata obliquata</i>	FE	No	No effect
Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	FT	No	No effect
Sheepnose Mussel	<i>Plethobasus cyphus</i>	FE	No	No effect
Snuffbox Mussel	<i>Epioblasma triquetra</i>	FE	No	No effect
Insects				
Monarch Butterfly	<i>Danaus plexippus</i>	FC	Yes	N/A as this species is not afforded protections under the ESA
Plants				
Short's Bladderpod	<i>Physaria globosa</i>	FE	Yes	May affect, not likely to adversely affect

Common Name	Scientific Name	Status ¹	Potential Habitat Present	Effect Finding
Birds				
Bald Eagle	Haliaeetus leucocephalus	BGEPA	No	No effect
¹ BGEPA: Bald and Golden Eagle Protection Act; FE: Federally Endangered; FT: Federally Threatened; SE: State Endangered; ST: State Threatened				

This section provides a description of state and federal T&E species identified in the desktop Endangered Species Review, along with a description of the species' preferred habitat, any preferred habitat observed during the field survey, and recommendations for avoidance. Figure 2 illustrates the habitat communities present in the Project Area.

A description of these species follows:

Gray Bat (*Myotis grisescens*)

Gray bat is a federally listed endangered species. The IPaC indicated gray bat may be present at or near the Project Area. Gray bat occupies limestone-karst caves year-round. In the winter, gray bat hibernates in deep, vertical caves, and in the summer, they roost in caves along rivers. The KDFWR and IPaC system did not indicate any caves or critical habitat in the Project Area. Potential suitable habitat was not observed within the Project Area as the sinkholes identified were characterized as sinkhole ponds lacking cave openings or exposed rock. A survey for gray bat is not recommended by Tetra Tech, as these sinkholes do not appear to provide suitable habitat.

Indiana Bat (*Myotis sodalis*)

Indiana bat (IB) is a federally listed endangered species. The IPaC indicated IB may be present in the Project Area. The bats, their roosting areas, and hibernacula are protected under the ESA. While a portion of the Project Area contains forested tracts and scattered forested areas that are suitable roosting habitat for these species, it is assumed that the Project will be constructed in the agricultural portions of the Project Area, and this habitat will not be disturbed during construction. If tree-clearing is required for the Project, time of year tree-clearing restrictions during the tree roosting period from April 1 through October 31. If disturbances can be avoided during this time period, no further restrictions related to these species would be required. Alternatively, Appendix F of the USFWS Range-Wide Indiana Bat Summer Survey Guidance (USFWS 2020) states that a qualified biologist can conduct emergence surveys of known or potential bat roosts (i.e., trees with greater than 3 inch diameter at breast height, sloughing bark, dead trees) to determine if the bats are present prior to removal if tree removal cannot take place outside of tree roosting season. Generally, the USFWS only approves emergence surveys for projects that will affect a very small number of potential roosts in relatively small project areas.

Northern Long-Eared Bat (*Myotis septentrionalis*)

The northern long-eared bat (NLEB) is a federally listed threatened species. The IPaC indicated NLEB may be present in the Project Area. The bats, their roosting areas, and hibernacula are protected under the ESA. Incidental take resulting from tree removal is prohibited if it: (1) occurs within ¼ mile (0.4 kilometer) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31). The IPaC system determines whether a project is within 0.25 mile of a known NLEB hibernaculum or within 150 feet of a known maternity roost tree. The IPaC system did not identify the project maternity roosts. Therefore, the Project would be able to rely on the Final 4(d) Rule for the NLEB and will be exempt from tree clearing time of year restrictions (TOYRs). A USFWS clearance letter should be obtained through the IPaC system prior to any tree clearing within the Project Area.

Virginia Big-eared Bat (*Plecotus townsendii virginianus*)

Virginia big-eared bat is a federally listed endangered species. The IPaC indicated the Virginia big-eared bat may be present at or near the Project Area. Virginia big-eared bat inhabits caves year-round. These caves are typically located in karst regions characterized by limestone caves and sinkholes dominated by oak-hickory or beech-maple-hemlock forests. The KDFWR and IPaC system did not indicate any caves or critical habitat were identified in the Project Area. Potential suitable habitat was not observed within the Project Area as the sinkholes identified were characterized as sinkhole ponds lacking cave openings or exposed rock. A survey for gray bat is not recommended by Tetra Tech, as these sinkholes do not appear to provide suitable habitat.

Clubshell (*Pleurobema clava*)

Clubshell mussel is a federally listed endangered species. The IPaC indicated the clubshell mussel may be present in the Project Area. The clubshell mussel prefers clean, loose sand and gravel in medium to small rivers and streams. This mussel will bury itself in the bottom substrates to depths of up to 4 inches. The intermittent and perennial streams within the Project Area are slightly turbid to turbid, slow flowing streams with predominantly clay, silt, and sand substrates with minimal gravel components. Therefore, these streams and any ephemeral streams within the Project Area do not provide suitable habitat for the clubshell mussel.

Fanshell (*Cyprogenia stegria*)

Fanshell mussel is a federally listed endangered species. The IPaC indicated the fanshell mussel may be present in the Project Area. The fanshell mussel inhabits medium to large rivers. It has been reported primarily from deep water habitat, with gravel substrate and moderate current. The intermittent and perennial streams within the Project Area are slow flowing streams with predominantly clay, silt, and sand substrates with minimal gravel components. Therefore, these streams and any ephemeral streams within the Project Area do not provide suitable habitat for the fanshell mussel.

Purple Cat's Paw (*Epioblasma obliquata obliquata*)

Purple cat's paw is a federally listed endangered species. The IPaC indicated the purple cat's paw may be present in the Project Area. The purple cat's paw prefers shallow, gravelly riffle zones of large rivers. The intermittent and perennial streams within the Project Area are slow flowing streams with predominantly clay, silt, and sand substrates with minimal gravel components. Therefore, these streams and any ephemeral streams within the Project Area do not provide suitable habitat for the purple cat's paw.

Rabbitsfoot (*Quadrula cylindrica cylindrica*)

Rabbitsfoot mussel is a federally listed endangered species. The IPaC indicated the rabbitsfoot mussel may be present in the Project Area. The rabbitsfoot mussel inhabits small to medium sized rivers, typically in shallow waters adjacent to runs and shoals where water velocity is reduced; however, it is occasionally found in deep water runs. This species also typically prefers streams with gravel and sand substrates. Although, the majority of the streams within the Project Area are slow flowing in nature, the substrates associated with the intermittent and perennial streams within the Project Area are predominantly silt, clay, and sand. Therefore, these streams and any ephemeral streams within the Project Area do not likely contain suitable habitat for the rabbitsfoot mussel.

Sheepnose Mussel (*Plethobasus cyphus*)

Sheepnose mussel is a federally listed endangered species. The IPaC indicated the sheepnose mussel may be present in the Project Area. The sheepnose mussel occupies large rivers and streams where they are usually found in shallow areas with moderate to swift currents that flow over coarse sand and gravel. However, they also have been found in areas of mud, cobble, and boulders, and in large rivers they may be found in deep runs. The intermittent and perennial streams within the Project Area are slow flowing streams with predominantly clay, silt, and sand substrates with minimal gravel components. Therefore, these streams and any ephemeral streams within the Project Area do not provide suitable habitat for the sheepnose mussel.

Snuffbox Mussel (*Epioblasma triquetra*)

Snuffbox mussel is a federally listed endangered species. The IPaC indicated the snuffbox mussel may be present in the Project Area. The snuffbox is usually found in small- to medium-sized creeks, inhabiting areas with a swift current, although it also is found in Lake Erie and some larger rivers. The intermittent and perennial streams within the Project Area are slow flowing streams with predominantly clay, silt, and sand substrates with minimal gravel components. Therefore, these streams and any ephemeral streams within the Project Area do not provide suitable habitat for the snuffbox mussel.

Monarch Butterfly (*Danaus plexippus*)

Monarch butterfly is a candidate for federal listing as an endangered species. The IPaC indicated the monarch butterfly may be present in the Project Area. The insect is typically found in open fields and meadows that contain milkweed (*Asclepias* spp.). Milkweed is essential for breeding habitat for monarch butterfly. As the majority of the Project Area is in agricultural/livestock production with a few grassed areas along streams, drainages and ponds or impoundments, there is suitable habitat present. However, this species is not granted protections under the ESA and therefore, avoidance and mitigation measures are not required at this time.

Short's Bladderpod (*Physaria globosa*)

Short's bladderpod is a federally listed endangered species. The IPaC indicated Short's bladderpod may be present in the Project Area. Short's bladderpod is typically found on steep, rocky wooded slopes and talus areas, occurring along cliff tops and bases of cliff ledges. Additionally, it occurs adjacent to rivers or streams, and on south to west facing slopes. Tetra Tech identified several areas of potential Short's bladderpod habitat in the Project Area (Figure 4). These potential habitat areas should be avoided during proposed Project activities. If disturbance of potential habitat cannot be avoided, a qualified biologist should conduct a survey of potential habitat that will be disturbed to determine if this species is present. Areas of potential Short's bladderpod habitat should be surveyed during the flowering season that occurs in April to early June. Consultation with USFWS is recommended for concurrence.

CONCLUSIONS AND RECOMMENDATIONS

Wildlife habitat is one of the primary factors to consider while designing the Project. Based on the available literature, publicly available state and federal resources, and field surveys, the Project Area does not contain any federally designated critical habitat for T&E listed species identified in the IPaC or by OKNP. The Project Area does appear to have suitable habitat for the following state and federally listed species: IB, NLEB, monarch butterfly, and Short's bladderpod. Therefore, these species have the potential to be present within the Project Area. Additionally, the ESA does not protect species on private land unless there is a federal nexus (i.e. a U.S. Army Corps of Engineers Section 404 permit). Therefore, activities on private lands that do not have federal involvement are not required to comply with ESA.

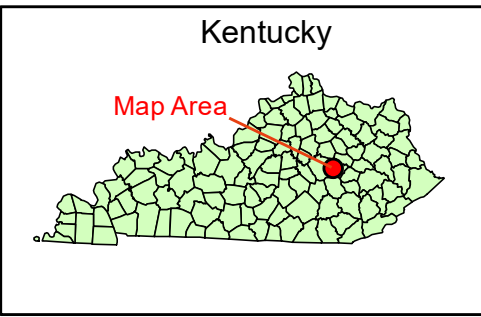
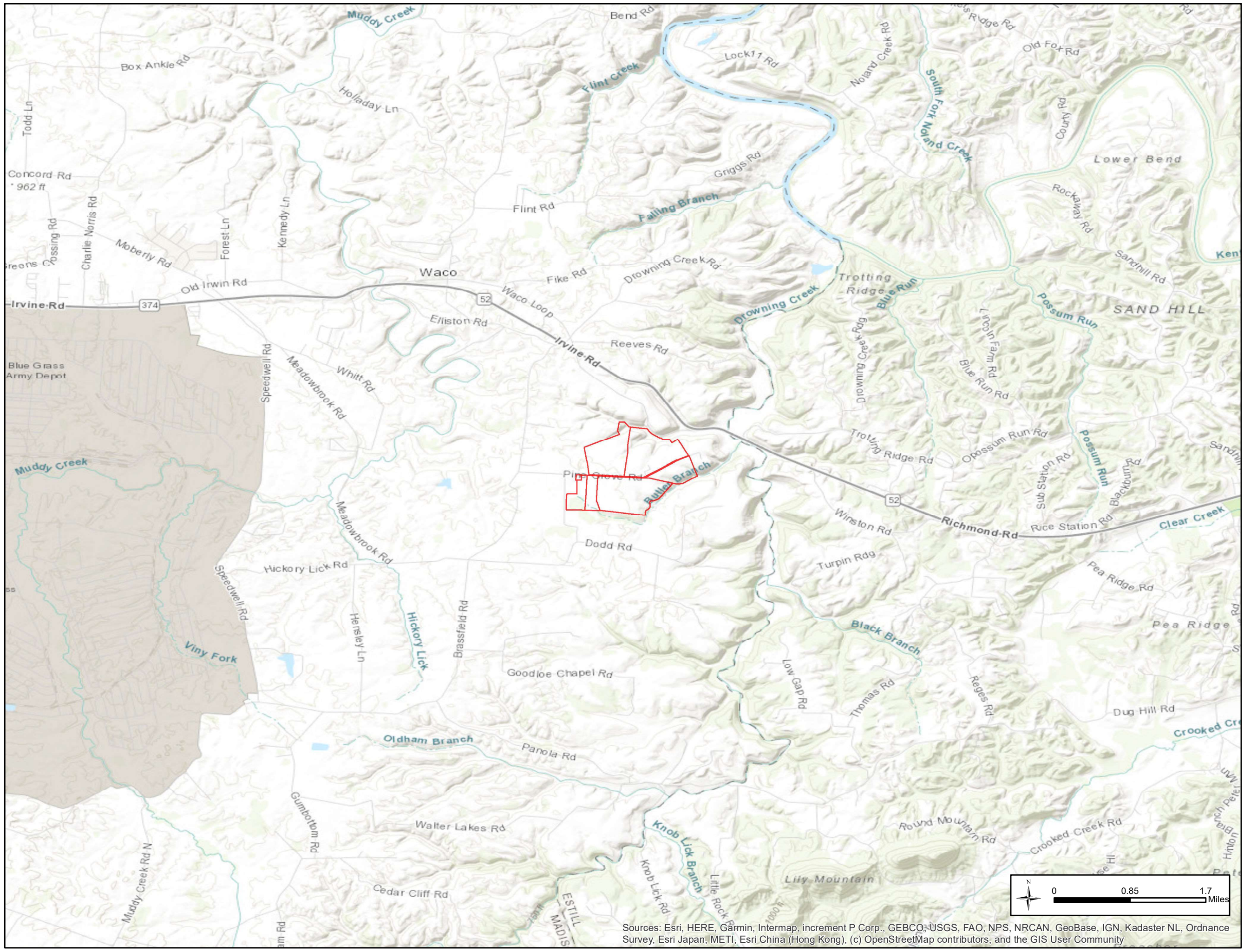
Based on the habitat verification survey conducted for the Project, Tetra Tech makes the following recommendations:

- The IB, their roosting areas, and hibernacula are federally protected under the ESA. Tetra Tech recommends assuming these bats are present and abiding by the applicable TOYRs, avoiding all tree-clearing from April 1 through October 31. If disturbances can be avoided during this time period, no further restrictions related to these bat species would be required. If tree clearing activities cannot be avoided, then presence/absence surveys will likely be required by the USFWS;
- In regard to the NLEB, no additional survey would be necessary due to lack of known hibernacula or maternity sites within the specified range of the Project Area as dictated by the Final 4(d) rule. The Final 4(d) rule will apply to the Project. A USFWS clearance letter should be obtained through the IPaC system prior to any tree clearing within the Project Area;
- Forested areas and tree clearing should be avoided to minimize Impacts to potential habitat for Short's bladderpod. Tetra Tech recommends consultation with USFWS to determine if a Project Area survey is recommended, and if so, to request survey guidance. Surveys for Short's bladderpod can be conducted from April to June, which is the flowering period for this species.

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FIGURES



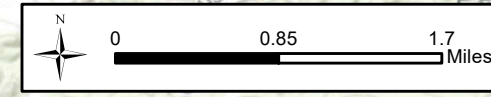
Legend

Surveyed Parcels

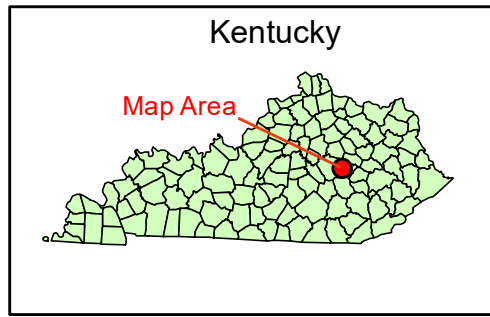
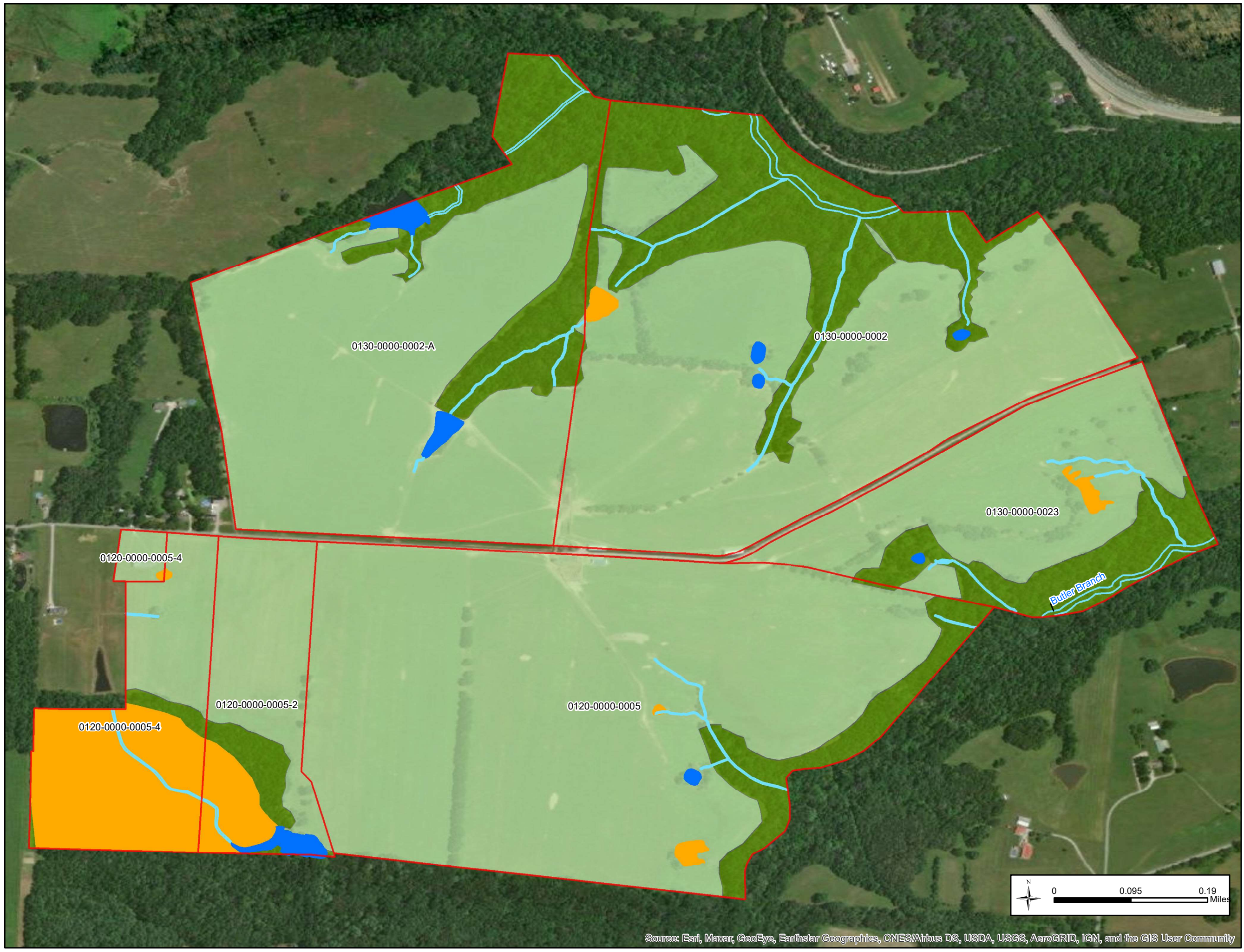


Project Vicinity
Pine Grove Solar Project
Madison County
Kentucky

Figure 1



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



Legend

- Surveyed Parcels
- Stream Line
- Pond or Impoundment
- Wetland Polygon
- Forested
- Pasture

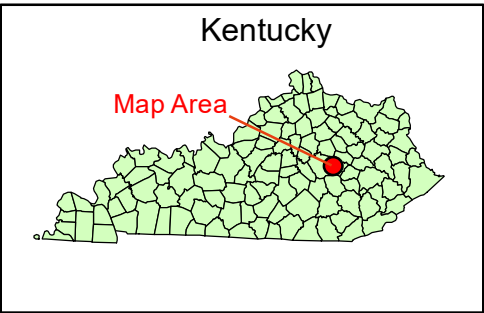
*Features were field delineated by Tetra Tech in November 2021



Habitat Map
Pine Grove Solar Project
Madison County
Kentucky

Figure 2

Date: 1/3/2022



Legend

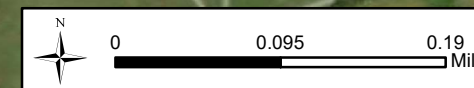
- Surveyed Parcels
- Sinkhole locations



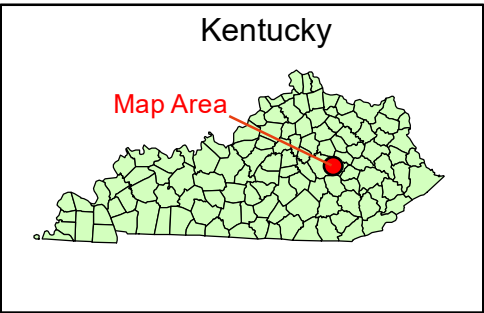
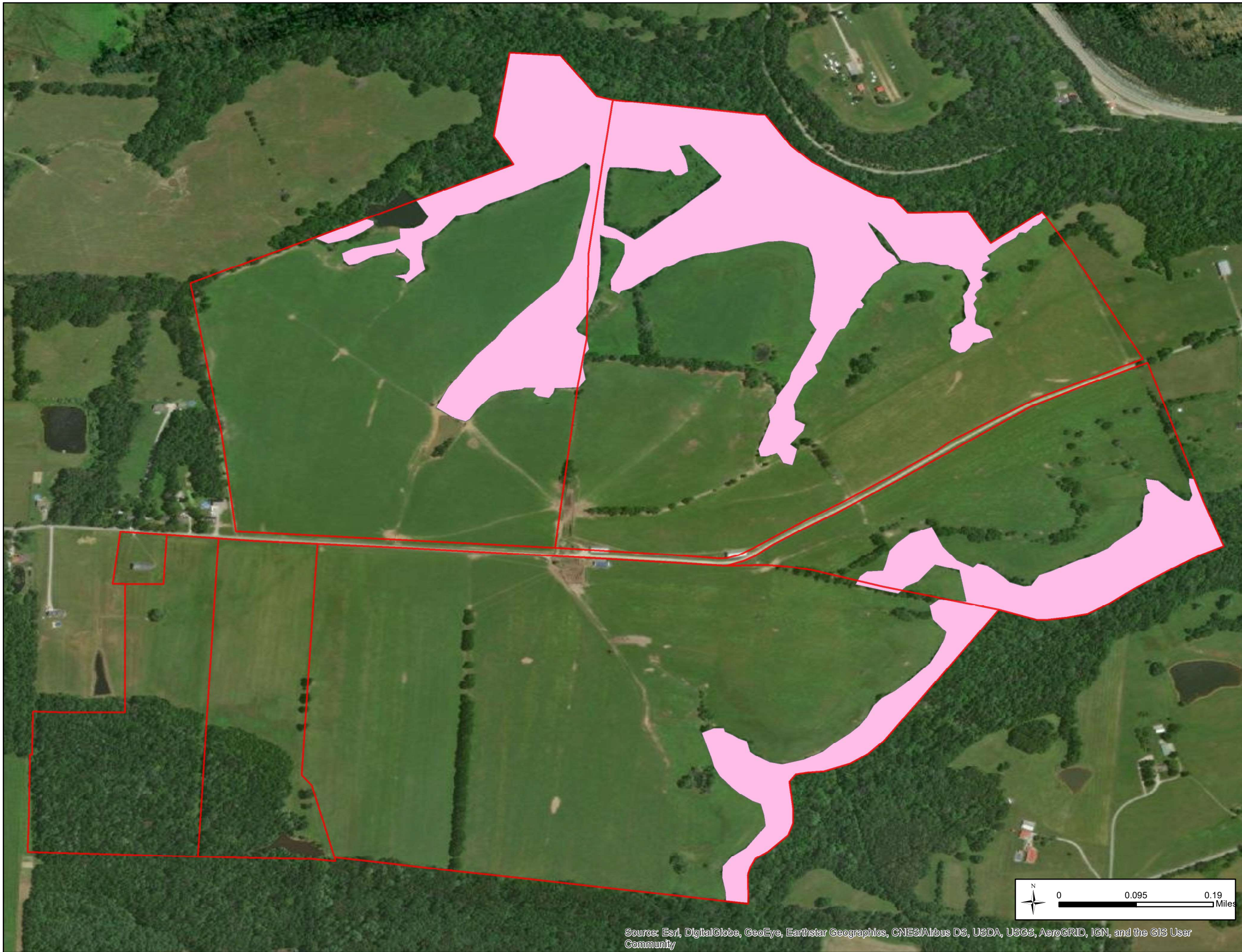
Sinkhole Locations Map
Pine Grove Solar Project
Madison County
Kentucky

Figure 3

Date: 11/29/2021



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



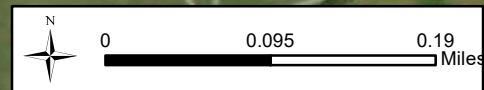
Legend

- Surveyed Parcels
- Potential Habitat



**Short's Bladderpod
Potential Habitat**

**Pine Grove Solar Project
Madison County
Kentucky**



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 4

Date: 11/24/2021

ATTACHMENT A
Results of Kentucky Biological Assessment Tool from Office of Kentucky Nature Preserves



ANDY BESHEAR
GOVERNOR

REBECCA W. GOODMAN
SECRETARY

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November 2, 2021

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Tetra Tech, Inc.
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Glen Allen, VA 23060

Project: Pine Grove Project
Project ID: 22-0068
Project Type: Standard (*customers will be invoiced), 1 mile buffer
(\$120 fee)
Site Acreage: 471.83
Site Lat/Lon: 37.711418 / -84.114954
County: Madison
USGS Quad: MOBERLY; PANOLA
Watershed HUC12: Drowning Creek

Dear Jennifer DAugustine,

This letter is in response to your data request for the project referenced above. We have reviewed our Natural Heritage Program Database to determine if any of the endangered, threatened, or special concern plants and animals or exemplary natural communities monitored by the Office of Kentucky Nature Preserves occur within your general project area. Your project does pose a concern at this time, therefore please see the attached reports and [report key](#) for more detailed information.

I would like to take this opportunity to remind you of the terms of the data request license, which you agreed upon in order to submit your request. The license agreement states "Data and data products received from the Office of Kentucky Nature Preserves, including any portion thereof, may not be reproduced in any form or by any means without the express written authorization of the Office of Kentucky Nature Preserves." The exact location of plants, animals, and natural communities, if released by the Office of Kentucky Nature Preserves, may not be released in any document or correspondence. These products are provided on a temporary basis for the express project (described above) of the requester, and may not be redistributed, resold or copied without the written permission of the Biological Assessment Branch (300 Sower Blvd - 4th Floor, Frankfort, KY, 40601. Phone: 502-782-7828).

Please note that the quantity and quality of data collected by the Kentucky Natural Heritage Program are dependent on the research and observations of many individuals and organizations. In most cases, this information is not the

Project ID: 22-0068
November 2, 2021
Page 2

result of comprehensive or site-specific field surveys; many natural areas in Kentucky have never been thoroughly surveyed and new plants and animals are still being discovered. For these reasons, the Kentucky Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of Kentucky. Heritage reports summarize the existing information known to the Kentucky Natural Heritage Program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments. We would greatly appreciate receiving any pertinent information obtained as a result of on-site surveys.

If you have any questions, or if I can be of further assistance, please do not hesitate to contact me.

Sincerely,

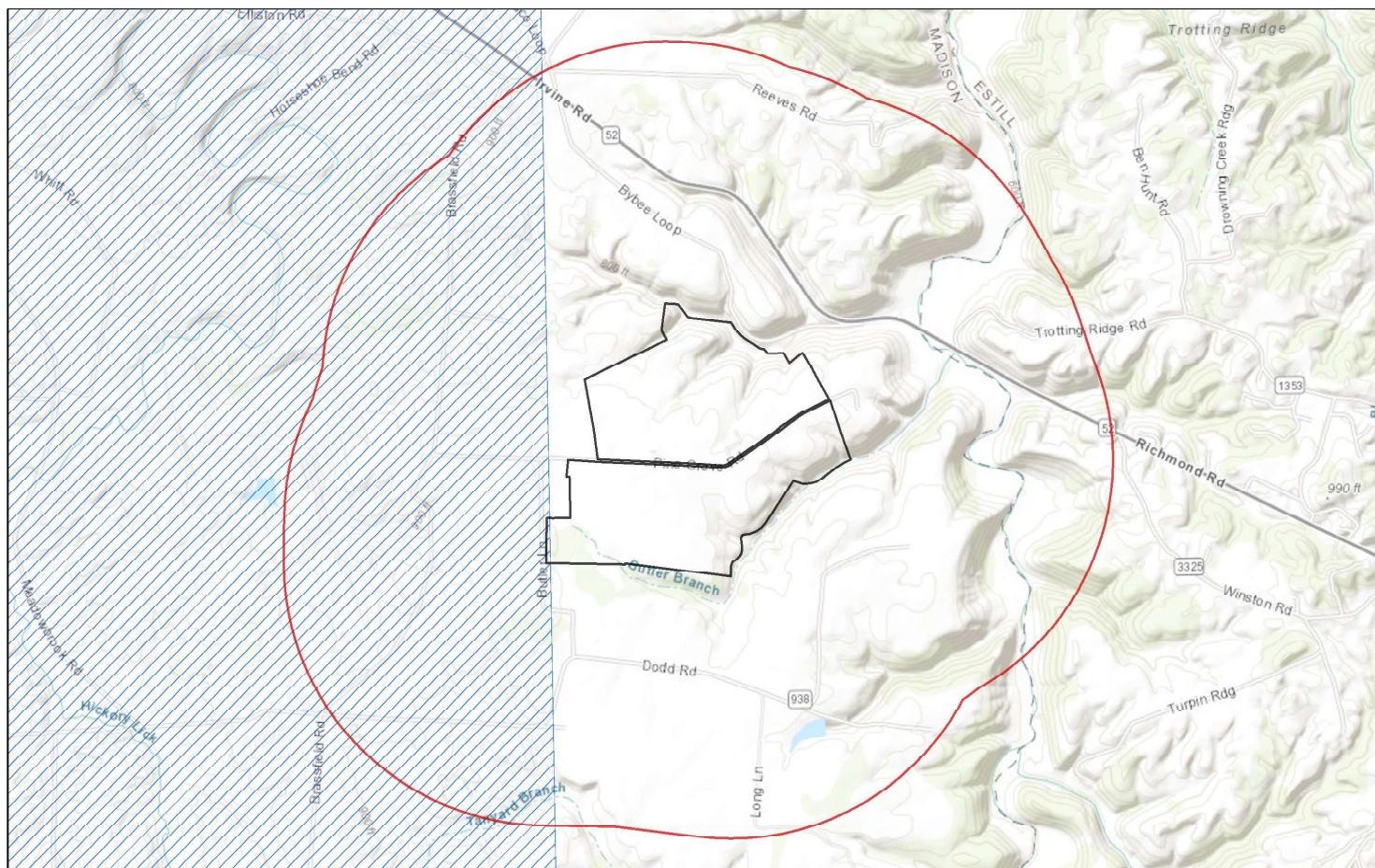
Alexis R Schoenlaub
Geoprocessing Specialist

Standard Occurrence Report
KNP monitored species within 1 Miles of Project Area




EO ID	Scientific Name	Common Name	GRank	SRank	SPROT	USES A	STWG	Last Obs Date	Precision	EO Rank	Lat / Lon	Directions	Habitat
15941	<i>Lanius ludovicianus</i>	Loggerhead Shrike	G4	S3S4B,S 4N	S	SOMC	Y	1987	Q	NR	37.6875 / -84.1875	Somewhere on quadrangle outside of SW block.	

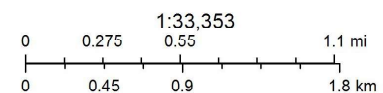
THESE DATA ARE VALID ONLY ON THE DATE ON WHICH THE REPORT WAS GENERATED.
 THESE DATA MAY ONLY BE USED FOR THE PROJECT NAMED ABOVE.

Pine Grove Project



November 2, 2021

-  Project Boundary
-  Buffered Project Boundary
-  Element Occurences



Sources: Eeri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri

ATTACHMENT B
**Results of Information for Planning and Conservation Tool from U.S. Fish and
Wildlife Service**

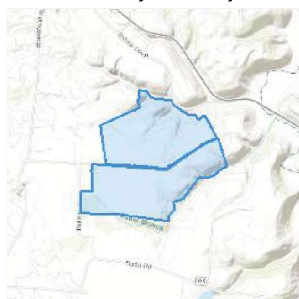
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Madison County, Kentucky



Local office

Kentucky Ecological Services Field Office

☎ (502) 695-0468

📠 (502) 695-1024

J C Watts Federal Building, Room 265

330 West Broadway

Frankfort, KY 40601-8670

<http://www.fws.gov/frankfort/>

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream) because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act requires Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species¹ and their critical habitats are managed by the [Ecological Services Program](#) of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries).

Species and critical habitats under the sole responsibility of NOAA Fisheries are not shown on this list. Please contact [NOAA Fisheries](#) for [species under their jurisdiction](#).

1. Species listed under the [Endangered Species Act](#) are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the [listing status page](#) for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. [NOAA Fisheries](#) also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
<p>Gray Bat <i>Myotis grisescens</i></p> <p>Wherever found</p> <p>This species only needs to be considered if the following condition applies:</p> <ul style="list-style-type: none"> • The project area includes potential gray bat habitat. <p>No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/6329</p>	Endangered
<p>Indiana Bat <i>Myotis sodalis</i></p> <p>Wherever found</p> <p>This species only needs to be considered if the following condition applies:</p> <ul style="list-style-type: none"> • The project area includes 'potential' habitat. All activities in this location should consider possible effects to this species. <p>There is final critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/5949</p>	Endangered
<p>Northern Long-eared Bat <i>Myotis septentrionalis</i></p> <p>Wherever found</p> <p>This species only needs to be considered if the following condition applies:</p> <ul style="list-style-type: none"> • The specified area includes areas in which incidental take would not be prohibited under the 4(d) rule. For reporting purposes, please use the "streamlined consultation form," linked to in the "general project design guidelines" for the species. <p>No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/9045</p>	Threatened
<p>Virginia Big-eared Bat <i>Corynorhinus (=Plecotus) townsendii virginianus</i></p> <p>Wherever found</p> <p>There is final critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/8369</p>	Endangered

Clams

NAME	STATUS
<p>Clubshell <i>Pleurobema clava</i></p> <p>This species only needs to be considered if the following condition applies:</p> <ul style="list-style-type: none"> • The species may be affected by projects that significantly impact the Kentucky River mainstem and/or any of its following tributaries: Dix River, Eagle Creek, Elkhorn Creek, North Fork Elkhorn Creek, and South Fork Kentucky River. <p>No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/3789</p>	Endangered

Fanshell *Cyprogenia stegaria* Endangered

Wherever found

This species only needs to be considered if the following condition applies:

- The species may be affected by projects that significantly impact the Kentucky River mainstem and/or any of its following tributaries: Dix River, Eagle Creek, Elkhorn Creek, North Fork Elkhorn Creek, and South Fork Kentucky River.

No critical habitat has been designated for this species.

<http://ecos.fws.gov/ecp/species/4822>

Purple Cat's Paw (=purple Cat's Paw Pearlymussel) *Epioblasma obliquata obliquata* Endangered

This species only needs to be considered if the following condition applies:

- The species may be affected by projects that significantly impact the Kentucky River mainstem and/or any of its following tributaries: Dix River, Eagle Creek, Elkhorn Creek, North Fork Elkhorn Creek, and South Fork Kentucky River.

No critical habitat has been designated for this species.

<http://ecos.fws.gov/ecp/species/5602>

Rabbitsfoot *Quadrula cylindrica cylindrica* Threatened

Wherever found

This species only needs to be considered if the following condition applies:

- The species may be affected by projects that significantly impact the Kentucky River mainstem and/or any of its following tributaries: Dix River, Eagle Creek, Elkhorn Creek, North Fork Elkhorn Creek, and South Fork Kentucky River.

There is **final** critical habitat for this species. The location of the critical habitat is not available.

<http://ecos.fws.gov/ecp/species/5165>

Sheepnose Mussel *Plethobasus cyphus* Endangered

Wherever found

This species only needs to be considered if the following condition applies:

- The species may be affected by projects that significantly impact the Kentucky River mainstem and/or any of its following tributaries: Dix River, Eagle Creek, Elkhorn Creek, North Fork Elkhorn Creek, and South Fork Kentucky River.

No critical habitat has been designated for this species.

<http://ecos.fws.gov/ecp/species/6903>

Snuffbox Mussel *Epioblasma triquetra* Endangered

Wherever found

No critical habitat has been designated for this species.

<http://ecos.fws.gov/ecp/species/4135>

Insects

NAME	STATUS
Monarch Butterfly <i>Danaus plexippus</i> Wherever found No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Short's Bladderpod <i>Physaria globosa</i> Wherever found There is final critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/7206	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

- The [Migratory Birds Treaty Act](#) of 1918.
- The [Bald and Golden Eagle Protection Act](#) of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern <http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php>
- Measures for avoiding and minimizing impacts to birds <http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php>
- Nationwide conservation measures for birds <http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf>

THERE ARE NO MIGRATORY BIRDS OF CONSERVATION CONCERN EXPECTED TO OCCUR AT THIS LOCATION.

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

[Nationwide Conservation Measures](#) describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. [Additional measures](#) or [permits](#) may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS [Birds of Conservation Concern \(BCC\)](#) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the [Avian Knowledge Network \(AKN\)](#). The AKN data is based on a growing collection of [survey, banding, and citizen science datasets](#) and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle ([Eagle Act](#) requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the [AKN Phenology Tool](#).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the [Avian Knowledge Network \(AKN\)](#). This data is derived from a growing collection of [survey, banding, and citizen science datasets](#).

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: [The Cornell Lab of Ornithology All About Birds Bird Guide](#), or (if you are unsuccessful in locating the bird of interest there), the [Cornell Lab of Ornithology Neotropical Birds guide](#). If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are [Birds of Conservation Concern \(BCC\)](#) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the [Eagle Act](#) requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the [Northeast Ocean Data Portal](#). The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the [NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf](#) project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the [Diving Bird Study](#) and the [nanotag studies](#) or contact [Caleb Spiegel](#) or [Pam Loring](#).

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to [obtain a permit](#) to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

Wildlife refuges and fish hatcheries

REFUGE AND FISH HATCHERY INFORMATION IS NOT AVAILABLE AT THIS TIME

Wetlands in the National Wetlands Inventory

Impacts to [NWI wetlands](#) and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local [U.S. Army Corps of Engineers District](#)

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the [NWI map](#) to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tubercid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

NOT FOR CONSULTATION

ATTACHMENT C
Stream Datasheets

STREAM ID 1		STREAM NAME Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.706548°	LONG -84.122908°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/08/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input type="checkbox"/> NRPW <input checked="" type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input checked="" type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>12.0</u> ft Top of Bank Height: LB <u>2.0</u> ft RB <u>2.0</u> ft Water Depth: <u>4.00</u> in Water Width: <u>6.0</u> ft Ordinary High Water Mark (Width): <u>10.0</u> ft Ordinary High Water Mark (Height): <u>12.0</u> in Flow Direction: <u>Southeast</u>	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input checked="" type="checkbox"/> Flat <input type="checkbox"/> Moderate <input type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input type="checkbox"/> None <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input type="checkbox"/> Stream bed moist <input checked="" type="checkbox"/> Standing water <input type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool 100 % Turbidity <input type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input checked="" type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	30			
Clay	< 0.004 mm (slick)	50			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input checked="" type="checkbox"/> Wide > 30ft <input type="checkbox"/> Moderate 15-30ft <input type="checkbox"/> Narrow <15ft
	Canopy Cover <input type="checkbox"/> Open <input type="checkbox"/> Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS
Parts of stream destroyed due to recent logging. Photos: View Northwest (Page 1), View Southeast (Page 1) Ephemeral Stream - The area was determined to be an ephemeral stream. The area possesses certain characteristics such as an incised channel and/or a defined bed and bank however, surface water only flows and/or pools in direct response to precipitation.

STREAM ID 4		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.718283°	LONG -84.116169°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>30.0</u> ft Top of Bank Height: LB <u>15.0</u> ft RB <u>15.0</u> ft Water Depth: <u>3.00</u> in Water Width: <u>8.0</u> ft Ordinary High Water Mark (Width): <u>15.0</u> ft Ordinary High Water Mark (Height): _____ in Flow Direction: Northeast _____	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat ___ Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast <input checked="" type="checkbox"/> Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 100 % Run % Pool % Turbidity ___ Clear <input checked="" type="checkbox"/> Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		20	Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	10			
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)	10			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft ___ Narrow <15ft
	Canopy Cover ___ Open ___ Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View Northeast (Page 1), View Southwest (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 6		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.717226°	LONG -84.111546°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input checked="" type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>60.0</u> ft Top of Bank Height: LB <u>5.0</u> ft RB <u>5.0</u> ft Water Depth: <u>12.00</u> in Water Width: <u>30.0</u> ft Ordinary High Water Mark (Width): <u>50.0</u> ft Ordinary High Water Mark (Height): <u>36.0</u> in Flow Direction: <u>East</u>	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat <input checked="" type="checkbox"/> Moderate ___ Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast <input checked="" type="checkbox"/> Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 40 % Run % Pool 60 % Turbidity ___ Clear ___ Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		30	Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	10			
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)	10			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width <input checked="" type="checkbox"/> Wide > 30ft ___ Moderate 15-30ft ___ Narrow <15ft
	Canopy Cover ___ Open ___ Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS
Photos: View East (Page 1), View West (Page 1) Perennial Stream - The area was determined to be a perennial stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristics to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously year-round in a typical year. Therefore, it is classified as perennial stream.

STREAM ID 7		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.716411°	LONG -84.113378°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>30.0</u> ft Top of Bank Height: LB <u>10.0</u> ft RB <u>10.0</u> ft Water Depth: <u>0.00</u> in Water Width: <u>0.0</u> ft Ordinary High Water Mark (Width): <u>6.0</u> ft Ordinary High Water Mark (Height): <u>24.0</u> in Flow Direction: Northeast _____	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input type="checkbox"/> Flat <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input type="checkbox"/> None <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input checked="" type="checkbox"/> Stream bed moist <input type="checkbox"/> Standing water <input type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool % Turbidity <input type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	10			
Cobble	64-256 mm (2.5"-10")	20	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)	10			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input type="checkbox"/> Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft <input type="checkbox"/> Narrow <15ft
	Canopy Cover <input type="checkbox"/> Open <input type="checkbox"/> Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View Northeast (Page 1), View Southwest (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 9		STREAM NAME Unnamed Tributary to Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.709530°	LONG -84.109203°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>15.0</u> ft Top of Bank Height: LB <u>3.0</u> ft RB <u>3.0</u> ft Water Depth: <u>1.00</u> in Water Width: <u>3.0</u> ft Ordinary High Water Mark (Width): <u>9.0</u> ft Ordinary High Water Mark (Height): <u>24.0</u> in Flow Direction: Northeast _____	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input type="checkbox"/> Flat <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input type="checkbox"/> None <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input type="checkbox"/> Stream bed moist <input type="checkbox"/> Standing water <input checked="" type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 20 % Run % Pool 80 % Turbidity <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	30			
Clay	< 0.004 mm (slick)	20			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input type="checkbox"/> Wide > 30ft <input type="checkbox"/> Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View Northeast (Page 1), View Southwest (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 10		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.715468°	LONG -84.108453°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>10.0</u> ft Top of Bank Height: LB <u>3.0</u> ft RB <u>3.0</u> ft Water Depth: <u>1.00</u> in Water Width: <u>2.0</u> ft Ordinary High Water Mark (Width): <u>4.0</u> ft Ordinary High Water Mark (Height): <u>24.0</u> in Flow Direction: North _____	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat ___ Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast ___ Moderate <input checked="" type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 20 % Run % Pool 80 % Turbidity ___ Clear <input checked="" type="checkbox"/> Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	10	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	40			
Clay	< 0.004 mm (slick)	30			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial <input checked="" type="checkbox"/> Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft ___ Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover ___ Open <input checked="" type="checkbox"/> Partly shaded ___ Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View North (Page 1), View South (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 15		STREAM NAME Unnamed Tributary to Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.711544°	LONG -84.105109°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>15.0</u> ft Top of Bank Height: LB <u>3.0</u> ft RB <u>3.0</u> ft Water Depth: <u>1.00</u> in Water Width: <u>2.0</u> ft Ordinary High Water Mark (Width): <u>9.0</u> ft Ordinary High Water Mark (Height): <u>24.0</u> in Flow Direction: <u>East</u>	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input type="checkbox"/> Flat <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input type="checkbox"/> None <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input type="checkbox"/> Stream bed moist <input type="checkbox"/> Standing water <input checked="" type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 40 % Run % Pool 60 % Turbidity <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	10			
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	30			
Clay	< 0.004 mm (slick)	20			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input type="checkbox"/> Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft <input type="checkbox"/> Narrow <15ft
	Canopy Cover <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View East (Page 1), View West (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 17		STREAM NAME Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.710201°	LONG -84.105631°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input checked="" type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>50.0</u> ft Top of Bank Height: LB <u>5.0</u> ft RB <u>5.0</u> ft Water Depth: <u>3.00</u> in Water Width: <u>25.0</u> ft Ordinary High Water Mark (Width): <u>30.0</u> ft Ordinary High Water Mark (Height): _____ in Flow Direction: North _____	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat <input checked="" type="checkbox"/> Moderate ___ Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast <input checked="" type="checkbox"/> Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 60 % Run % Pool 40 % Turbidity ___ Clear <input checked="" type="checkbox"/> Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		50	Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	20			
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	10	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)				

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft ___ Narrow <15ft
	Canopy Cover ___ Open ___ Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View North (Page 1), View South (Page 1)
Perennial Stream - The area was determined to be a perennial stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristics to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously year-round in a typical year. Therefore, it is classified as perennial stream.

STREAM ID 18		STREAM NAME Unnamed Tributary to Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.710059°	LONG -84.108230°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/08/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>15.0</u> ft Top of Bank Height: LB <u>2.0</u> ft RB <u>2.0</u> ft Water Depth: <u>1.00</u> in Water Width: <u>3.0</u> ft Ordinary High Water Mark (Width): <u>6.0</u> ft Ordinary High Water Mark (Height): <u>12.0</u> in Flow Direction: <u>East</u>	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat <input checked="" type="checkbox"/> Moderate ___ Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast <input checked="" type="checkbox"/> Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 100 % Run % Pool % Turbidity ___ Clear ___ Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	10	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	40			
Clay	< 0.004 mm (slick)	30			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft ___ Narrow <15ft
	Canopy Cover ___ Open ___ Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View East (Page 1), View West (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 19		STREAM NAME Unnamed Tributary to Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.709530°	LONG -84.109203°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/08/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input type="checkbox"/> NRPW <input checked="" type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input checked="" type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>25.0</u> ft Top of Bank Height: LB <u>20.0</u> ft RB <u>20.0</u> ft Water Depth: <u>0.00</u> in Water Width: <u>0.0</u> ft Ordinary High Water Mark (Width): <u>8.0</u> ft Ordinary High Water Mark (Height): <u>12.0</u> in Flow Direction: <u>East</u>	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat ___ Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry <input checked="" type="checkbox"/> Stream bed moist ___ Standing water ___ Flowing water Velocity ___ Fast ___ Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool % Turbidity ___ Clear ___ Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")	50			
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	10			
Clay	< 0.004 mm (slick)				

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft ___ Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover ___ Open ___ Partly shaded <input checked="" type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View East (Page 1), View West (Page 1)
Ephemeral Stream - The area was determined to be an ephemeral stream. The area possesses certain characteristics such as an incised channel and/or a defined bed and bank however, surface water only flows and/or pools in direct response to precipitation.

STREAM ID 20		STREAM NAME Unnamed Tributary to Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.706896°	LONG -84.112702°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>12.0</u> ft Top of Bank Height: LB <u>3.0</u> ft RB <u>3.0</u> ft Water Depth: <u>4.00</u> in Water Width: <u>6.0</u> ft Ordinary High Water Mark (Width): <u>8.0</u> ft Ordinary High Water Mark (Height): <u>24.0</u> in Flow Direction: <u>Southeast</u>	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat ___ Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast ___ Moderate <input checked="" type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 50 % Run % Pool 50 % Turbidity ___ Clear <input checked="" type="checkbox"/> Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	40			
Clay	< 0.004 mm (slick)	40			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial <input checked="" type="checkbox"/> Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft ___ Narrow <15ft
	Canopy Cover ___ Open <input checked="" type="checkbox"/> Partly shaded ___ Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View Northwest (Page 1), View Southeast (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 22		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.714320°	LONG -84.116156°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>15.0</u> ft Top of Bank Height: LB <u>4.0</u> ft RB <u>4.0</u> ft Water Depth: <u>0.00</u> in Water Width: <u>0.0</u> ft Ordinary High Water Mark (Width): <u>8.0</u> ft Ordinary High Water Mark (Height): <u>24.0</u> in Flow Direction: Northeast _____	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input type="checkbox"/> Flat <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input type="checkbox"/> None <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input checked="" type="checkbox"/> Stream bed moist <input type="checkbox"/> Standing water <input type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool % Turbidity <input type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)	40			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest <input type="checkbox"/> Commercial <input type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input type="checkbox"/> Wide > 30ft <input checked="" type="checkbox"/> Moderate 15-30ft <input type="checkbox"/> Narrow <15ft
	Canopy Cover <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View Northeast (Page 1), View Southwest (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 23		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.715952°	LONG -84.118423°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input type="checkbox"/> NRPW <input checked="" type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input checked="" type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>20.0</u> ft Top of Bank Height: LB <u>3.0</u> ft RB <u>3.0</u> ft Water Depth: <u>0.00</u> in Water Width: <u>0.0</u> ft Ordinary High Water Mark (Width): <u>4.0</u> ft Ordinary High Water Mark (Height): <u>6.0</u> in Flow Direction: North _____	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat ___ Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry <input checked="" type="checkbox"/> Stream bed moist ___ Standing water ___ Flowing water Velocity ___ Fast ___ Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool % Turbidity ___ Clear ___ Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	30			
Clay	< 0.004 mm (slick)	40			

WATERSHED FEATURES	Predominant Surrounding Landuse <input checked="" type="checkbox"/> Forest ___ Commercial ___ Field/Pasture ___ Industrial ___ Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft ___ Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover ___ Open <input checked="" type="checkbox"/> Partly shaded ___ Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View North (Page 1), View South (Page 1)
Ephemeral Stream - The area was determined to be an ephemeral stream. The area possesses certain characteristics such as an incised channel and/or a defined bed and bank however, surface water only flows and/or pools in direct response to precipitation.

STREAM ID 24		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.716321°	LONG -84.119496°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input checked="" type="checkbox"/> NRPW <input type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input checked="" type="checkbox"/> Ephemeral <input type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>10.0</u> ft Top of Bank Height: LB <u>2.0</u> ft RB <u>2.0</u> ft Water Depth: <u>2.00</u> in Water Width: <u>4.0</u> ft Ordinary High Water Mark (Width): <u>6.0</u> ft Ordinary High Water Mark (Height): <u>12.0</u> in Flow Direction: Northeast _____	Sinuosity ___ Low <input checked="" type="checkbox"/> Medium ___ High Gradient ___ Flat <input checked="" type="checkbox"/> Moderate ___ Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion ___ None <input checked="" type="checkbox"/> Moderate ___ Heavy Artificial, Modified or Channelized ___ Yes <input checked="" type="checkbox"/> No Within Roadside Ditch ___ Yes <input checked="" type="checkbox"/> No Culvert Present ___ Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present ___ No water, stream bed dry ___ Stream bed moist ___ Standing water <input checked="" type="checkbox"/> Flowing water Velocity ___ Fast ___ Moderate ___ Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle 40 % Run % Pool 60 % Turbidity ___ Clear <input checked="" type="checkbox"/> Slightly turbid ___ Turbid ___ Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")	10	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	30			
Clay	< 0.004 mm (slick)	40			

WATERSHED FEATURES	Predominant Surrounding Landuse ___ Forest ___ Commercial ___ Field/Pasture ___ Industrial <input checked="" type="checkbox"/> Agricultural ___ Residential ___ ROW ___ Other:	Floodplain Width ___ Wide > 30ft ___ Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover ___ Open <input checked="" type="checkbox"/> Partly shaded ___ Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Spring fed.
Photos: View Northwest (Page 1), View East (Page 1)
Intermittent Stream - The area was determined to be an intermittent stream. This area exhibits positive indicators for dominant hydrophytic vegetation, positive indicators of hydric soils, and evidence of hydrology. The area also possesses characteristic to classify it as water of the U.S. due to the presence of an incised channel, defined bed and bank, and surface water flowing continuously during certain times of the year in a typical year. Therefore, it is classified as an intermittent stream.

STREAM ID 25		STREAM NAME Unnamed Tributary to Butler Branch	
CLIENT AES		PROJECT NAME Pine Grove	
LAT 37.709512°	LONG -84.123279°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/08/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input type="checkbox"/> NRPW <input checked="" type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input checked="" type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>18.0</u> ft Top of Bank Height: LB <u>2.0</u> ft RB <u>2.0</u> ft Water Depth: <u>1.00</u> in Water Width: <u>6.0</u> ft Ordinary High Water Mark (Width): <u>15.0</u> ft Ordinary High Water Mark (Height): <u>12.0</u> in Flow Direction: <u>West</u>	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input checked="" type="checkbox"/> Flat <input type="checkbox"/> Moderate <input type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input checked="" type="checkbox"/> None <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input type="checkbox"/> Stream bed moist <input checked="" type="checkbox"/> Standing water <input type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool 100 % Turbidity <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	30			
Clay	< 0.004 mm (slick)	50			

WATERSHED FEATURES	Predominant Surrounding Landuse <input type="checkbox"/> Forest <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input type="checkbox"/> Wide > 30ft <input type="checkbox"/> Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover <input checked="" type="checkbox"/> Open <input type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS

Photos: View East (Page 1), View West (Page 1)
Ephemeral Stream - The area was determined to be an ephemeral stream. The area possesses certain characteristics such as an incised channel and/or a defined bed and bank however, surface water only flows and/or pools in direct response to precipitation.

STREAM ID 29		STREAM NAME Unnamed Tributary to Drowning Creek	
CLIENT AES		PROJECT NAME Pine Grove Solar	
LAT 37.716313°	LONG -84.114580°	STATE KY	COUNTY Madison
INVESTIGATORS Brandon Schack and Kendall Bennett		DATE 11/09/2021	
WATER TYPE TNW <input type="checkbox"/> RPW <input type="checkbox"/> NRPW <input checked="" type="checkbox"/>		FLOW REGIME Perennial <input type="checkbox"/> Intermittent <input type="checkbox"/> Ephemeral <input checked="" type="checkbox"/>	

CHANNEL FEATURES	Estimate Measurements Top of Bank Width: <u>8.0</u> ft Top of Bank Height: LB <u>2.0</u> ft RB <u>2.0</u> ft Water Depth: <u>1.00</u> in Water Width: <u>2.0</u> ft Ordinary High Water Mark (Width): <u>5.0</u> ft Ordinary High Water Mark (Height): <u>12.0</u> in Flow Direction: Northeast _____	Sinuosity <input checked="" type="checkbox"/> Low <input type="checkbox"/> Medium <input type="checkbox"/> High Gradient <input type="checkbox"/> Flat <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Severe (0.5/100 ft) (2 ft/100 ft) (10 ft/100 ft) Stream Erosion <input type="checkbox"/> None <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Heavy Artificial, Modified or Channelized <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Within Roadside Ditch <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Present <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Culvert Material: _____ Culvert Size: _____ in
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FLOW CHARACTERISTICS	Water Present <input type="checkbox"/> No water, stream bed dry <input checked="" type="checkbox"/> Stream bed moist <input type="checkbox"/> Standing water <input type="checkbox"/> Flowing water Velocity <input type="checkbox"/> Fast <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Slow	Proportion of Reach Represented by Stream Morphology Types (Only enter if water present) Riffle % Run % Pool % Turbidity <input type="checkbox"/> Clear <input type="checkbox"/> Slightly turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Other _____
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INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) ¹⁰⁰			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	20
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	10			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	20			
Clay	< 0.004 mm (slick)	40			

WATERSHED FEATURES	Predominant Surrounding Landuse <input type="checkbox"/> Forest <input type="checkbox"/> Commercial <input checked="" type="checkbox"/> Field/Pasture <input type="checkbox"/> Industrial <input type="checkbox"/> Agricultural <input type="checkbox"/> Residential <input type="checkbox"/> ROW <input type="checkbox"/> Other:	Floodplain Width <input type="checkbox"/> Wide > 30ft <input type="checkbox"/> Moderate 15-30ft <input checked="" type="checkbox"/> Narrow <15ft
	Canopy Cover <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly shaded <input type="checkbox"/> Shaded	

MACROINVERTEBRATES/OTHER WILDLIFE OBSERVED OR OTHER NOTES AND OBSERVATIONS
Photos: View Northeast (Page 1), View Southwest (Page 1) Ephemeral Stream - The area was determined to be an ephemeral stream. The area possesses certain characteristics such as an incised channel and/or a defined bed and bank however, surface water only flows and/or pools in direct response to precipitation

ATTACHMENT D
Sinkhole Photographs



Site 11: View South 11/9/2021



Site 12: View North 11/9/2021



Site 13: View North 11/9/2021



Site 21: View South 11/9/2021



Site 26: View North 11/9/2021



Site 26: View South 11/9/2021



Site 28: View East 11/8/2021



Site 28: View West 11/8/2021



Site 30: View East 11/9/2021



Site 30: View West 11/9/2021

FORGESOLAR GLARE ANALYSIS

Project: **Pine Grove Solar**

Site configuration: **Pine Grove_220901**

Created 30 Aug, 2022

Updated 01 Sep, 2022

Time-step 1 minute

Timezone offset UTC-5

Site ID 74931.13236

Category 10 MW to 100 MW

DNI peaks at 1,000.0 W/m²

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

Methodology V2

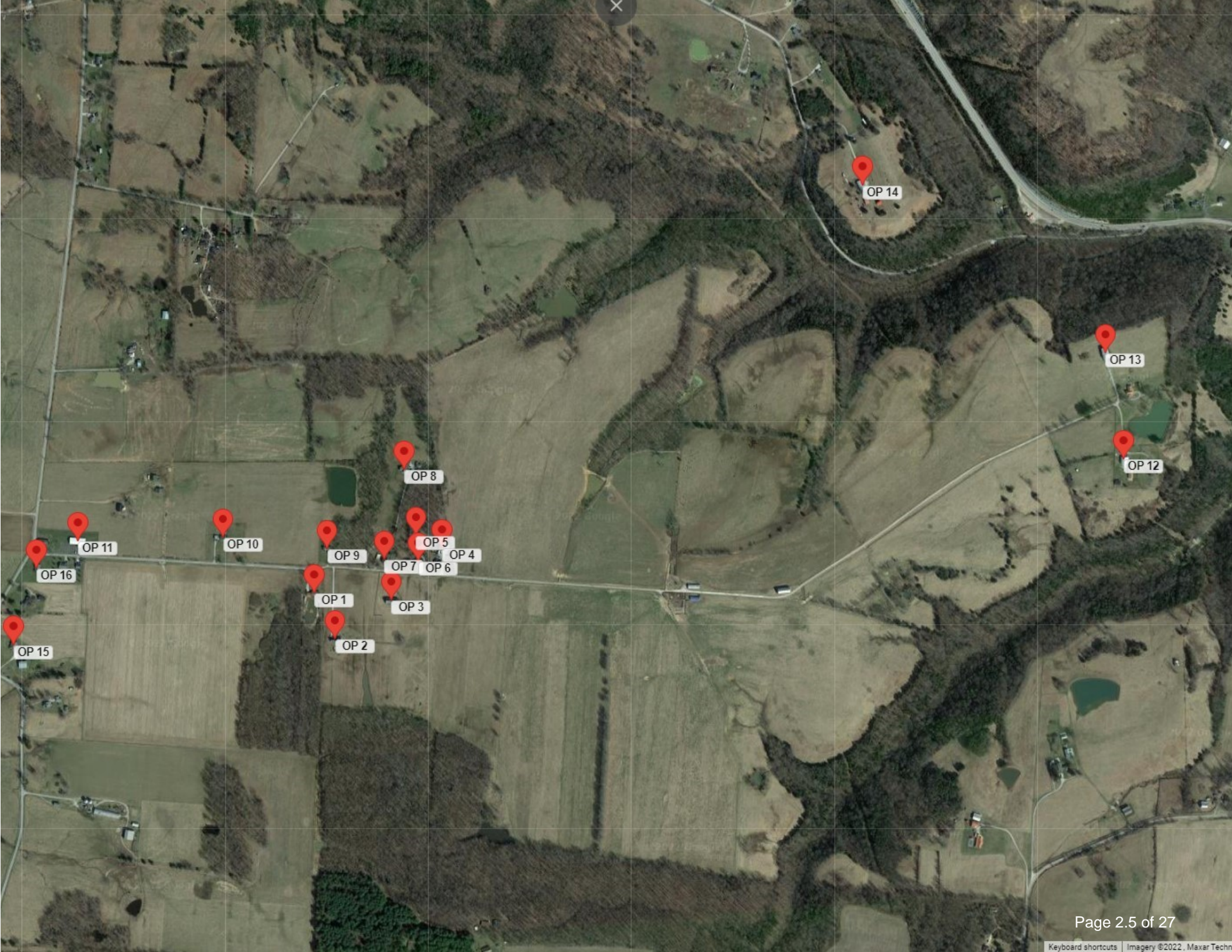
Summary of Results No glare predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV5	SA tracking	SA tracking	0	0.0	0	0.0	-
PV6	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0

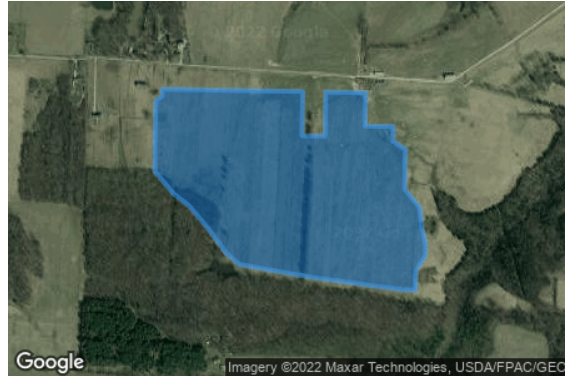
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0



Component Data

PV Arrays

Name: PV1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 55.0°
Resting angle: 10.0°
Ground Coverage Ratio: 0.48
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.710313	-84.122613	880.04	5.00	885.04
2	37.710247	-84.117784	880.04	5.00	885.04
3	37.709050	-84.117810	880.04	5.00	885.04
4	37.709039	-84.117022	880.04	5.00	885.04
5	37.710236	-84.116996	880.04	5.00	885.04
6	37.710217	-84.115622	880.04	5.00	885.04
7	37.709314	-84.115641	880.04	5.00	885.04
8	37.709301	-84.114672	880.04	5.00	885.04
9	37.708901	-84.114681	880.04	5.00	885.04
10	37.708683	-84.114255	880.04	5.00	885.04
11	37.707596	-84.114278	880.04	5.00	885.04
12	37.707095	-84.113753	880.04	5.00	885.04
13	37.706542	-84.113694	880.04	5.00	885.04
14	37.706113	-84.113557	880.04	5.00	885.04
15	37.705806	-84.113563	880.04	5.00	885.04
16	37.705397	-84.113895	880.04	5.00	885.04
17	37.704868	-84.113907	880.04	5.00	885.04
18	37.704874	-84.114355	880.04	5.00	885.04
19	37.705211	-84.117476	880.04	5.00	885.04
20	37.705564	-84.119976	880.04	5.00	885.04
21	37.705877	-84.120420	880.04	5.00	885.04
22	37.706559	-84.121064	880.04	5.00	885.04
23	37.707150	-84.121691	880.04	5.00	885.04
24	37.707473	-84.122222	880.04	5.00	885.04
25	37.707775	-84.122544	880.04	5.00	885.04
26	37.708089	-84.122877	880.04	5.00	885.04
27	37.709994	-84.122836	880.04	5.00	885.04
28	37.710126	-84.122618	880.04	5.00	885.04
29	37.710313	-84.122613	880.04	5.00	885.04

Name: PV2

Axis tracking: Single-axis rotation

Backtracking: Shade-slope

Tracking axis orientation: 180.0°

Max tracking angle: 55.0°

Resting angle: 5.0°

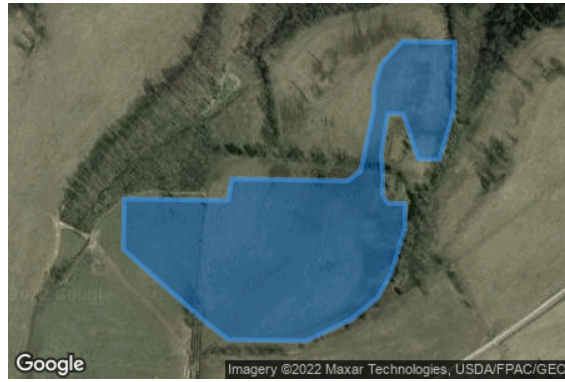
Ground Coverage Ratio: 0.48

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.713875	-84.112474	880.04	5.00	885.04
2	37.713585	-84.112481	880.04	5.00	885.04
3	37.713476	-84.112386	880.04	5.00	885.04
4	37.713472	-84.112085	880.04	5.00	885.04
5	37.713125	-84.112093	880.04	5.00	885.04
6	37.712527	-84.112326	880.04	5.00	885.04
7	37.712201	-84.112559	880.04	5.00	885.04
8	37.711902	-84.113012	880.04	5.00	885.04
9	37.711610	-84.113795	880.04	5.00	885.04
10	37.711629	-84.115127	880.04	5.00	885.04
11	37.711872	-84.115528	880.04	5.00	885.04
12	37.712851	-84.116930	880.04	5.00	885.04
13	37.713537	-84.116916	880.04	5.00	885.04
14	37.713512	-84.115131	880.04	5.00	885.04
15	37.713807	-84.115068	880.04	5.00	885.04
16	37.713780	-84.113084	880.04	5.00	885.04
17	37.713909	-84.112859	880.04	5.00	885.04
18	37.714756	-84.112627	880.04	5.00	885.04
19	37.715043	-84.112621	880.04	5.00	885.04
20	37.715357	-84.112500	880.04	5.00	885.04
21	37.715671	-84.112138	880.04	5.00	885.04
22	37.715659	-84.111232	880.04	5.00	885.04
23	37.714724	-84.111253	880.04	5.00	885.04
24	37.714071	-84.111499	880.04	5.00	885.04
25	37.714076	-84.111868	880.04	5.00	885.04
26	37.714689	-84.112126	880.04	5.00	885.04
27	37.714692	-84.112391	880.04	5.00	885.04
28	37.714130	-84.112497	880.04	5.00	885.04
29	37.713875	-84.112474	880.04	5.00	885.04

Name: PV3

Axis tracking: Single-axis rotation

Backtracking: Shade-slope

Tracking axis orientation: 180.0°

Max tracking angle: 55.0°

Resting angle: 5.0°

Ground Coverage Ratio: 0.48

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.711149	-84.108979	880.04	5.00	885.04
2	37.710550	-84.109607	880.04	5.00	885.04
3	37.710417	-84.109706	880.04	5.00	885.04
4	37.710122	-84.108880	880.04	5.00	885.04
5	37.709746	-84.108888	880.04	5.00	885.04
6	37.709765	-84.110253	880.04	5.00	885.04
7	37.709181	-84.110537	880.04	5.00	885.04
8	37.709185	-84.110766	880.04	5.00	885.04
9	37.709512	-84.111345	880.04	5.00	885.04
10	37.709856	-84.111338	880.04	5.00	885.04
11	37.710451	-84.110091	880.04	5.00	885.04
12	37.710448	-84.109845	880.04	5.00	885.04
13	37.710611	-84.109732	880.04	5.00	885.04
14	37.711005	-84.109314	880.04	5.00	885.04
15	37.711177	-84.109343	880.04	5.00	885.04
16	37.711384	-84.109695	880.04	5.00	885.04
17	37.711851	-84.109685	880.04	5.00	885.04
18	37.712564	-84.108473	880.04	5.00	885.04
19	37.713139	-84.107378	880.04	5.00	885.04
20	37.713429	-84.106598	880.04	5.00	885.04
21	37.713422	-84.106100	880.04	5.00	885.04
22	37.712787	-84.105784	880.04	5.00	885.04
23	37.712436	-84.105791	880.04	5.00	885.04
24	37.712456	-84.107237	880.04	5.00	885.04
25	37.711671	-84.107254	880.04	5.00	885.04
26	37.711661	-84.106575	880.04	5.00	885.04
27	37.711224	-84.106477	880.04	5.00	885.04
28	37.711213	-84.105711	880.04	5.00	885.04
29	37.710837	-84.105719	880.04	5.00	885.04
30	37.710394	-84.107185	880.04	5.00	885.04
31	37.710406	-84.108058	880.04	5.00	885.04
32	37.711139	-84.108258	880.04	5.00	885.04
33	37.711149	-84.108979	880.04	5.00	885.04

Name: PV4

Axis tracking: Single-axis rotation

Backtracking: Shade-slope

Tracking axis orientation: 180.0°

Max tracking angle: 55.0°

Resting angle: 5.0°

Ground Coverage Ratio: 0.48

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.714925	-84.109689	880.04	5.00	885.04
2	37.714917	-84.109122	880.04	5.00	885.04
3	37.714325	-84.108812	880.04	5.00	885.04
4	37.714319	-84.108410	880.04	5.00	885.04
5	37.714610	-84.108188	880.04	5.00	885.04
6	37.714597	-84.107210	880.04	5.00	885.04
7	37.714267	-84.106743	880.04	5.00	885.04
8	37.713924	-84.106750	880.04	5.00	885.04
9	37.713605	-84.107544	880.04	5.00	885.04
10	37.713035	-84.108629	880.04	5.00	885.04
11	37.712094	-84.110266	880.04	5.00	885.04
12	37.711797	-84.110830	880.04	5.00	885.04
13	37.711813	-84.111941	880.04	5.00	885.04
14	37.712171	-84.111933	880.04	5.00	885.04
15	37.713059	-84.111034	880.04	5.00	885.04
16	37.713423	-84.110506	880.04	5.00	885.04
17	37.713713	-84.110499	880.04	5.00	885.04
18	37.713999	-84.109954	880.04	5.00	885.04
19	37.714596	-84.109941	880.04	5.00	885.04
20	37.714925	-84.109689	880.04	5.00	885.04

Name: PV5

Axis tracking: Single-axis rotation

Backtracking: Shade-slope

Tracking axis orientation: 180.0°

Max tracking angle: 55.0°

Resting angle: 5.0°

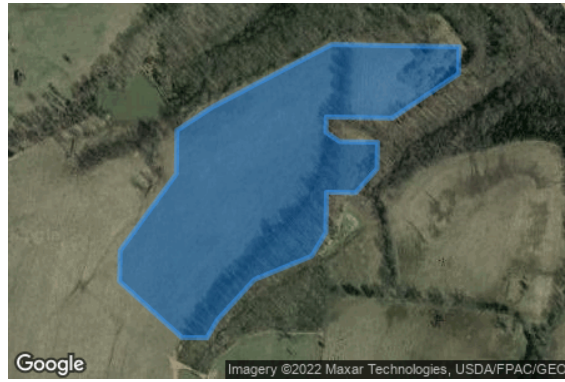
Ground Coverage Ratio: 0.48

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.717527	-84.115327	880.04	5.00	885.04
2	37.717497	-84.113181	880.04	5.00	885.04
3	37.717129	-84.113189	880.04	5.00	885.04
4	37.716531	-84.114327	880.04	5.00	885.04
5	37.716547	-84.115464	880.04	5.00	885.04
6	37.716338	-84.115468	880.04	5.00	885.04
7	37.716212	-84.115229	880.04	5.00	885.04
8	37.716203	-84.114582	880.04	5.00	885.04
9	37.715843	-84.114590	880.04	5.00	885.04
10	37.715520	-84.114957	880.04	5.00	885.04
11	37.715527	-84.115458	880.04	5.00	885.04
12	37.714980	-84.115470	880.04	5.00	885.04
13	37.714661	-84.115713	880.04	5.00	885.04
14	37.714343	-84.116698	880.04	5.00	885.04
15	37.713791	-84.117340	880.04	5.00	885.04
16	37.713555	-84.117512	880.04	5.00	885.04
17	37.713561	-84.117945	880.04	5.00	885.04
18	37.714319	-84.119014	880.04	5.00	885.04
19	37.714736	-84.119005	880.04	5.00	885.04
20	37.715773	-84.118040	880.04	5.00	885.04
21	37.716363	-84.118027	880.04	5.00	885.04
22	37.716667	-84.117449	880.04	5.00	885.04
23	37.717523	-84.115380	880.04	5.00	885.04

Name: PV6

Axis tracking: Single-axis rotation

Backtracking: Shade-slope

Tracking axis orientation: 180.0°

Max tracking angle: 55.0°

Resting angle: 10.0°

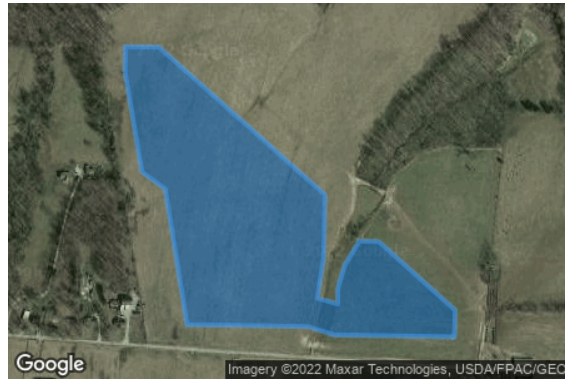
Ground Coverage Ratio: 0.48

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.714997	-84.121405	880.04	5.00	885.04
2	37.712998	-84.118552	880.04	5.00	885.04
3	37.712160	-84.118570	880.04	5.00	885.04
4	37.711596	-84.118682	880.04	5.00	885.04
5	37.711518	-84.118335	880.04	5.00	885.04
6	37.711740	-84.118330	880.04	5.00	885.04
7	37.712046	-84.118211	880.04	5.00	885.04
8	37.712369	-84.117964	880.04	5.00	885.04
9	37.712365	-84.117632	880.04	5.00	885.04
10	37.711436	-84.116316	880.04	5.00	885.04
11	37.711071	-84.116324	880.04	5.00	885.04
12	37.711099	-84.118398	880.04	5.00	885.04
13	37.711209	-84.118844	880.04	5.00	885.04
14	37.711238	-84.120923	880.04	5.00	885.04
15	37.713077	-84.121299	880.04	5.00	885.04
16	37.713307	-84.121698	880.04	5.00	885.04
17	37.714660	-84.121989	880.04	5.00	885.04
18	37.715005	-84.121982	880.04	5.00	885.04
19	37.714997	-84.121405	880.04	5.00	885.04

Route Receptors

Name: Brassfield Rd
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.706362	-84.133317	908.77	0.00	908.77
2	37.707525	-84.133328	905.76	0.00	905.76
3	37.708297	-84.133253	908.79	0.00	908.79
4	37.708544	-84.133371	902.61	0.00	902.61
5	37.708713	-84.133628	901.63	0.00	901.63
6	37.708943	-84.134197	909.58	0.00	909.58
7	37.709214	-84.134508	908.05	0.00	908.05
8	37.709435	-84.134605	906.39	0.00	906.39
9	37.711480	-84.133070	919.69	0.00	919.69
10	37.715447	-84.132448	900.63	0.00	900.63
11	37.719436	-84.131847	876.86	0.00	876.86
12	37.721914	-84.131654	888.72	0.00	888.72

Name: Bybee Loop Rd
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.718451	-84.102880	626.04	0.00	626.04
2	37.718256	-84.103105	625.46	0.00	625.46
3	37.718188	-84.104489	635.15	0.00	635.15
4	37.718205	-84.106130	633.89	0.00	633.89
5	37.718230	-84.106452	636.69	0.00	636.69
6	37.718179	-84.106903	639.48	0.00	639.48
7	37.718120	-84.107203	648.22	0.00	648.22
8	37.717543	-84.108888	684.16	0.00	684.16
9	37.717441	-84.109424	689.38	0.00	689.38
10	37.717424	-84.109800	695.66	0.00	695.66
11	37.717484	-84.110218	707.93	0.00	707.93
12	37.717611	-84.110733	715.65	0.00	715.65
13	37.717865	-84.111173	726.40	0.00	726.40
14	37.718129	-84.111430	737.86	0.00	737.86
15	37.719181	-84.112133	757.00	0.00	757.00
16	37.719418	-84.112219	769.00	0.00	769.00
17	37.719770	-84.112214	779.58	0.00	779.58
18	37.720297	-84.112085	803.18	0.00	803.18
19	37.720492	-84.112122	803.61	0.00	803.61
20	37.720687	-84.112214	813.16	0.00	813.16
21	37.721231	-84.112444	826.27	0.00	826.27
22	37.721837	-84.112605	834.54	0.00	834.54
23	37.722190	-84.112766	842.62	0.00	842.62
24	37.722420	-84.112965	845.03	0.00	845.03
25	37.723642	-84.115813	855.86	0.00	855.86
26	37.724049	-84.116720	866.66	0.00	866.66
27	37.726883	-84.120958	875.68	0.00	875.68
28	37.727376	-84.121634	878.71	0.00	878.71

Name: Pine Grove Rd
Path type: Two-way
Observer view angle: 50.0°



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Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.714621	-84.103819	826.74	0.00	826.74
2	37.713365	-84.107341	846.60	0.00	846.60
3	37.713076	-84.107942	850.98	0.00	850.98
4	37.712075	-84.109723	869.33	0.00	869.33
5	37.711570	-84.110580	877.45	0.00	877.45
6	37.710790	-84.112178	888.33	0.00	888.33
7	37.710560	-84.112500	894.33	0.00	894.33
8	37.710501	-84.112736	893.89	0.00	893.89
9	37.710484	-84.112908	893.64	0.00	893.64
10	37.711155	-84.125031	913.27	0.00	913.27
11	37.711104	-84.125343	914.76	0.00	914.76
12	37.711443	-84.132885	923.49	0.00	923.49
13	37.711481	-84.133030	920.45	0.00	920.45

Name: Rt 52
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.711339	-84.083718	787.84	0.00	787.84
2	37.718075	-84.099404	622.57	0.00	622.57
3	37.718380	-84.100079	620.38	0.00	620.38
4	37.718550	-84.101002	618.67	0.00	618.67
5	37.718533	-84.101914	619.04	0.00	619.04
6	37.718465	-84.102257	619.25	0.00	619.25
7	37.718414	-84.103738	636.30	0.00	636.30
8	37.718456	-84.104553	643.68	0.00	643.68
9	37.718694	-84.105326	654.31	0.00	654.31
10	37.719059	-84.105991	663.73	0.00	663.73
11	37.719585	-84.106560	675.04	0.00	675.04
12	37.724781	-84.110894	765.52	0.00	765.52
13	37.725494	-84.111752	777.19	0.00	777.19
14	37.725901	-84.113018	791.63	0.00	791.63
15	37.726359	-84.115700	819.21	0.00	819.21
16	37.726750	-84.116688	830.48	0.00	830.48
17	37.727395	-84.117696	842.71	0.00	842.71
18	37.733038	-84.126923	910.66	0.00	910.66
19	37.736279	-84.132931	875.63	0.00	875.63
20	37.739843	-84.139325	875.38	0.00	875.38

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	37.710578	-84.125399	920.22	0.00
OP 2	2	37.709596	-84.124843	917.41	0.00
OP 3	3	37.710428	-84.123320	916.89	0.00
OP 4	4	37.711552	-84.121950	916.79	0.00
OP 5	5	37.711793	-84.122652	914.60	0.00
OP 6	6	37.711255	-84.122583	918.72	0.00
OP 7	7	37.711288	-84.123505	916.38	0.00
OP 8	8	37.713232	-84.122986	908.57	0.00
OP 9	9	37.711534	-84.125068	917.33	0.00
OP 10	10	37.711767	-84.127879	933.97	0.00
OP 11	11	37.711695	-84.131808	931.19	0.00
OP 12	12	37.713448	-84.103508	825.19	0.00
OP 13	13	37.715697	-84.104013	839.17	0.00
OP 14	14	37.719297	-84.110571	839.63	0.00
OP 15	15	37.709469	-84.133541	913.82	0.00
OP 16	16	37.711099	-84.132908	923.55	0.00

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt °	Orient °	Annual Green Glare		Annual Yellow Glare		Energy kWh
			min	hr	min	hr	
PV1	SA tracking	SA tracking	0	0.0	0	0.0	-
PV2	SA tracking	SA tracking	0	0.0	0	0.0	-
PV3	SA tracking	SA tracking	0	0.0	0	0.0	-
PV4	SA tracking	SA tracking	0	0.0	0	0.0	-
PV5	SA tracking	SA tracking	0	0.0	0	0.0	-
PV6	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV: PV1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV1 and Brassfield Rd

Receptor type: Route
No glare found

PV1 and Bybee Loop Rd

Receptor type: Route
No glare found

PV1 and Pine Grove Rd

Receptor type: Route
No glare found

PV1 and Rt 52

Receptor type: Route
No glare found

PV1 and OP 1

Receptor type: Observation Point
No glare found

PV1 and OP 2

Receptor type: Observation Point
No glare found

PV1 and OP 3

Receptor type: Observation Point
No glare found

PV1 and OP 4

Receptor type: Observation Point
No glare found

PV1 and OP 5

Receptor type: Observation Point
No glare found

PV1 and OP 6

Receptor type: Observation Point
No glare found

PV1 and OP 7

Receptor type: Observation Point
No glare found

PV1 and OP 8

Receptor type: Observation Point
No glare found

PV1 and OP 9

Receptor type: Observation Point
No glare found

PV1 and OP 10

Receptor type: Observation Point
No glare found

PV1 and OP 11

Receptor type: Observation Point
No glare found

PV1 and OP 12

Receptor type: Observation Point
No glare found

PV1 and OP 13

Receptor type: Observation Point
No glare found

PV1 and OP 14

Receptor type: Observation Point
No glare found

PV1 and OP 15

Receptor type: Observation Point
No glare found

PV1 and OP 16

Receptor type: Observation Point
No glare found

PV: PV2 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV2 and Brassfield Rd

Receptor type: Route
No glare found

PV2 and Bybee Loop Rd

Receptor type: Route
No glare found

PV2 and Pine Grove Rd

Receptor type: Route
No glare found

PV2 and Rt 52

Receptor type: Route
No glare found

PV2 and OP 1

Receptor type: Observation Point
No glare found

PV2 and OP 2

Receptor type: Observation Point
No glare found

PV2 and OP 3

Receptor type: Observation Point
No glare found

PV2 and OP 4

Receptor type: Observation Point
No glare found

PV2 and OP 5

Receptor type: Observation Point
No glare found

PV2 and OP 6

Receptor type: Observation Point
No glare found

PV2 and OP 7

Receptor type: Observation Point
No glare found

PV2 and OP 8

Receptor type: Observation Point
No glare found

PV2 and OP 9

Receptor type: Observation Point
No glare found

PV2 and OP 10

Receptor type: Observation Point
No glare found

PV2 and OP 11

Receptor type: Observation Point
No glare found

PV2 and OP 12

Receptor type: Observation Point
No glare found

PV2 and OP 13

Receptor type: Observation Point
No glare found

PV2 and OP 14

Receptor type: Observation Point
No glare found

PV2 and OP 15

Receptor type: Observation Point
No glare found

PV2 and OP 16

Receptor type: Observation Point
No glare found

PV: PV3 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV3 and Brassfield Rd

Receptor type: Route
No glare found

PV3 and Bybee Loop Rd

Receptor type: Route
No glare found

PV3 and Pine Grove Rd

Receptor type: Route
No glare found

PV3 and Rt 52

Receptor type: Route
No glare found

PV3 and OP 1

Receptor type: Observation Point
No glare found

PV3 and OP 2

Receptor type: Observation Point
No glare found

PV3 and OP 3

Receptor type: Observation Point
No glare found

PV3 and OP 4

Receptor type: Observation Point
No glare found

PV3 and OP 5

Receptor type: Observation Point
No glare found

PV3 and OP 6

Receptor type: Observation Point
No glare found

PV3 and OP 7

Receptor type: Observation Point
No glare found

PV3 and OP 8

Receptor type: Observation Point
No glare found

PV3 and OP 9

Receptor type: Observation Point
No glare found

PV3 and OP 10

Receptor type: Observation Point
No glare found

PV3 and OP 11

Receptor type: Observation Point
No glare found

PV3 and OP 12

Receptor type: Observation Point
No glare found

PV3 and OP 13

Receptor type: Observation Point
No glare found

PV3 and OP 14

Receptor type: Observation Point
No glare found

PV3 and OP 15

Receptor type: Observation Point
No glare found

PV3 and OP 16

Receptor type: Observation Point
No glare found

PV: PV4 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV4 and Brassfield Rd

Receptor type: Route
No glare found

PV4 and Bybee Loop Rd

Receptor type: Route
No glare found

PV4 and Pine Grove Rd

Receptor type: Route
No glare found

PV4 and Rt 52

Receptor type: Route
No glare found

PV4 and OP 1

Receptor type: Observation Point
No glare found

PV4 and OP 2

Receptor type: Observation Point
No glare found

PV4 and OP 3

Receptor type: Observation Point
No glare found

PV4 and OP 4

Receptor type: Observation Point
No glare found

PV4 and OP 5

Receptor type: Observation Point
No glare found

PV4 and OP 6

Receptor type: Observation Point
No glare found

PV4 and OP 7

Receptor type: Observation Point
No glare found

PV4 and OP 8

Receptor type: Observation Point
No glare found

PV4 and OP 9

Receptor type: Observation Point
No glare found

PV4 and OP 10

Receptor type: Observation Point
No glare found

PV4 and OP 11

Receptor type: Observation Point
No glare found

PV4 and OP 12

Receptor type: Observation Point
No glare found

PV4 and OP 13

Receptor type: Observation Point
No glare found

PV4 and OP 14

Receptor type: Observation Point
No glare found

PV4 and OP 15

Receptor type: Observation Point
No glare found

PV4 and OP 16

Receptor type: Observation Point
No glare found

PV: PV5 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV5 and Brassfield Rd

Receptor type: Route
No glare found

PV5 and Bybee Loop Rd

Receptor type: Route
No glare found

PV5 and Pine Grove Rd

Receptor type: Route
No glare found

PV5 and Rt 52

Receptor type: Route
No glare found

PV5 and OP 1

Receptor type: Observation Point
No glare found

PV5 and OP 2

Receptor type: Observation Point
No glare found

PV5 and OP 3

Receptor type: Observation Point
No glare found

PV5 and OP 4

Receptor type: Observation Point
No glare found

PV5 and OP 5

Receptor type: Observation Point
No glare found

PV5 and OP 6

Receptor type: Observation Point
No glare found

PV5 and OP 7

Receptor type: Observation Point
No glare found

PV5 and OP 8

Receptor type: Observation Point
No glare found

PV5 and OP 9

Receptor type: Observation Point
No glare found

PV5 and OP 10

Receptor type: Observation Point
No glare found

PV5 and OP 11

Receptor type: Observation Point
No glare found

PV5 and OP 12

Receptor type: Observation Point
No glare found

PV5 and OP 13

Receptor type: Observation Point
No glare found

PV5 and OP 14

Receptor type: Observation Point
No glare found

PV5 and OP 15

Receptor type: Observation Point
No glare found

PV5 and OP 16

Receptor type: Observation Point
No glare found

PV: PV6 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Brassfield Rd	0	0.0	0	0.0
Bybee Loop Rd	0	0.0	0	0.0
Pine Grove Rd	0	0.0	0	0.0
Rt 52	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0

PV6 and Brassfield Rd

Receptor type: Route

No glare found

PV6 and Bybee Loop Rd

Receptor type: Route

No glare found

PV6 and Pine Grove Rd

Receptor type: Route

No glare found

PV6 and Rt 52

Receptor type: Route

No glare found

PV6 and OP 1

Receptor type: Observation Point

No glare found

PV6 and OP 2

Receptor type: Observation Point

No glare found

PV6 and OP 3

Receptor type: Observation Point
No glare found

PV6 and OP 4

Receptor type: Observation Point
No glare found

PV6 and OP 5

Receptor type: Observation Point
No glare found

PV6 and OP 6

Receptor type: Observation Point
No glare found

PV6 and OP 7

Receptor type: Observation Point
No glare found

PV6 and OP 8

Receptor type: Observation Point
No glare found

PV6 and OP 9

Receptor type: Observation Point
No glare found

PV6 and OP 10

Receptor type: Observation Point
No glare found

PV6 and OP 11

Receptor type: Observation Point
No glare found

PV6 and OP 12

Receptor type: Observation Point
No glare found

PV6 and OP 13

Receptor type: Observation Point
No glare found

PV6 and OP 14

Receptor type: Observation Point
No glare found

PV6 and OP 15

Receptor type: Observation Point
No glare found

PV6 and OP 16

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.

Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.

The analysis does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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